Research Problem Review 77-11

LEVEL II

AD A076702

HUMAN FACTORS ASPECTS OF THE SB-3614 SWITCHBOARD

FORT HOOD FIELD UNIT

U. S. Army
Research Institute for the Behavioral and Social Sciences

December 1977

Army Project Number
(16) 2Q763743A775

Human Performance in
Field Assessment

(14) ARI- Research Problem Review 77-11

(6) HUMAN FACTORS ASPECTS OF THE SB-3614 SWITCHBOARD

(10) Ward A. Harris

Submitted by:
George M. Gividen, Chief
Fort Hood Field Unit

(11) December 1977 (12) 12

Approved by:

Joseph Zeidner, Director
Organizations and Systems
Research Laboratory

J. E. Uhlaner, Technical Director
US Army Research Institute for the
Behavioral and Social Sciences

Research Problem Reviews are special reports to military management. They are usually prepared to meet requests for research results bearing on specific management problems. A limited distribution is made--primarily to the operating agencies directly involved.

FOREWORD

By assessing the human performance aspects of man/weapons systems in field situations, the Fort Hood Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) provides evaluation support to Headquarters, TRADOC Combined Arms Test Activity (TCATA), formerly Modern Army Selected Systems Test Evaluation and Review (MASSTER).

MASSTER Test FM 260 was designed to support development of the SB-3614 automated tactical telephone switchboard. The present Research Problem Review assesses human factors aspects of the switchboard and constitutes input for the MASSTER test. The research reported is responsive to the objectives of Army Project 2Q763743A775, "Human Performance in Field Assessment."

J. E. UHLANER
Technical Director

(B)

HUMAN FACTORS ASPECTS OF THE SB-3614 SWITCHBOARD

BRIEF

Requirement:

To assess, evaluate, and report human engineering, training, and logistical support implications associated with use of the SB-3614 automatic switchboard.

Procedure:

Data were obtained through interviews with user personnel. Positive and negative features of the switchboard are reported in five content areas: (a) switchboard and converter covers, (b) front of switchboard and converter, (c) inside front of switchboard, (d) back of switchboard and converter, and (e) operating switchboard.

Principal Findings:

Respondents noted many positive features of the SB-3614 switchboard, among them the following:

- Covers are light and strong, and they provide convenient storage for ancillary equipment.
- Controls, markings, lighting, and fixtures are generally satisfactory, with specific exceptions; and
- Operation in automatic mode is easier and faster than for manual switchboards.

Numerous negative aspects were also reported:

- Storage of ancillary equipment is hampered by unsatisfactory retaining brackets.
- Design feature of separating converter from switchboard is inefficient;
- Certain routine maintenance and operating procedures are difficult or confusing to execute as a result of equipment design defects;
- Quality and types of selected signal lamps are unsatisfactory; and
- Power module generates annoying noise.

Utilization of Findings:

These findings, combined with the other findings of MASSTER test FM 260, provided input for the development and procurement of the SB-3614 switchboard.

HUMAN FACTORS ASPECTS OF THE SB-3614 SWITCHBOARD

BACKGROUND

The low-capacity, semiautomatic, tactical switchboard SB-3614 program was a two-phase, U.S. Marine Corps development effort. Phase I consisted of the development, test, and evaluation of an engineering model of the SB-3614 to provide operational and transmission performance characteristics. Phase II consisted of the design, fabrication, test, and evaluation of three service test models to insure compliance with specified performance factors, including those functions provided in the engineering model. Phase I testing was accomplished at the manufacturer's plant and was followed by Phase II testing conducted at Marine Corps bases at Quantico, Virginia and Camp LeJeune, North Carolina during April and September 1972. In December 1972, the Department of the Army assigned the Combat Development Command the task of developing a test plan for the SB-3614 switchboard. This action resulted in the inclusion of the switchboard in MASSTER test 165, Communications Switching Concepts. MASSTER test 165 was delayed because a high-capacity automatic switch system was not available, and the decision was made to evaluate the SB-3614 switchboard in a separate test, FM 260. This test was conducted by MASSTER with Army Research Institute (ARI) support during the period 13 May to 5 August 1974.

PURPOSE AND SPECIFIC OBJECTIVES

The purpose of the overall test was to evaluate the impact on the division telephone communications system of employing the SB-3614 switchboard at different echelons of command and within the Corps Command Operation Center. The test results provided input for the development and procurement programs of the SB-3614 automatic switchboard and will be used to evaluate possible doctrinal and organizational changes.

There were four test objectives:

1. To assess the operational characteristics and capabilities of the SB-3614 automatic switchboard.

2. To identify operational features desired in small unit-level automatic switchboards and associated end instruments.

3. To assess the operational effectiveness and suitability of employing switchboards at different echelons of command.

4. To report observed human engineering factors, training, and logistical support implications.

ARI was responsible for examining human factors implications in conjunction with objective 4.

PROCEDURES

The data on which the findings of this report are based were obtained through interviews of the test officer, a warrant officer technician, a civilian communications specialist, and the three enlisted switchboard operators for the test. The test officer and the communications specialist had worked with the SB-3614 for about eight months at the time of the interview. The others each had about one month's experience with the switchboard.

The interviewees' comments and opinions were synthesized in five categories:

1. Switchboard and converter covers.

2. Front of switchboard and converter.

3. Inside front of switchboard.

4. Back of switchboard and converter.

5. Operating switchboard.

RESULTS

In each of the five categories, findings regarding positive features and those regarding negative features are discussed separately, except for a few cases where closely related positive and negative features are included in the same paragraph. The number of the interviewees mentioning each positive or negative feature is given in brackets [ ] following the statement of the finding. Because of the small number of interviewees (six), the findings should be treated as reasonable hypotheses rather than definitive conclusions.

SWITCHBOARD AND CONVERTER COVERS

Positive features:

1. Little space is wasted in the covers; most available space is filled with equipment [1].

2. Covers are not bulky. They fit exactly on the front and back of the switchboard and thus add less weight than if the entire switchboard fitted in a case [1]. The covers are made of a strong plastic material which provides protection without adding undue weight [1].

3. The butterfly releases on the cover latches are easy to grip and turn [2].

4. The covers have no sharp corners or projections and do not present any safety hazard to the operator [2].

Negative features:

1. If the cover is on top of the switchboard when removal is attempted, the latches continue to hang down even when released and catch on the rim of the switchboard [5]. The operator must have assistance in holding the latches away from the switchboard rim in order to remove the cover. The alternative is to turn the switchboard over so that each cover is on the bottom when removed. The latches will then drop down and away, and the switchboard can be lifted off the cover.

2. The retaining brackets inside the cover are difficult to install and remove [3]. Originally the retaining brackets were attached to the covers with beaded chains. The chains were very light weight, however, and broke, allowing the brackets to separate from the covers. Two brackets have been lost [2]. The broken chains also allow the brackets to be used in the wrong place in the cover. When this occurs, the covers are more difficult to fit on the switchboard, the brackets are more difficult to remove, and the equipment can be damaged [3].

3. Even when installed correctly, the retaining brackets hold the equipment poorly [2]. When any item slips out of place even slightly the covers are difficult to put on and equipment may be damaged.

4. No diagram is provided to show how equipment is to be fitted into the covers; the foam rubber inserts help but are not sufficient [2]. Consequently, the different equipment items are sometimes put in the wrong cover or in the wrong place in a cover. When this happens the covers do not fit correctly on the switchboard, and if the covers are forced on, the switchboard and the equipment may be damaged.

An alternative type of retainer has been suggested, consisting of a solid flat piece of material that would fit over the entire inside of the cover [2]. The equipment and the spaces in the covers could be labeled to indicate where each item is to be positioned. Still another suggestion was to carry the equipment in a separate canvas bag and eliminate the need for retainers in the cover [1].

FRONT OF SWITCHBOARD AND CONVERTER

Positive features:

1. The control buttons, switches, and dials on the front of the switchboard all have an adequate size and shape [3]. In addition, the "click" that is heard and felt when a button or switch is used provides useful feedback to the operator [1]. The layout of the buttons, switches, and dials is generally acceptable [3].

2. Markings for the controls on the front of the switchboard are sufficient in number, and their meanings are either self-explanatory or easily learned [2]. All but two short word abbreviations on the control buttons were easily understood (the two that caused problems were CLD = Called [2] and OPR = Operator [1]). Of the single letter abbreviations the "I" is sometimes confused with the "1" [1].

3. The lighting on the front of the switchboard and converter is generally satisfactory [4]. One minor problem is that the lower identification strip for the terminal signal lights (TSL) is masked from the upper lights by the top row of TSLs. This makes the Lower Strip difficult to read [1]. The power-on light, the three failure lights, and the terminal signal lights are all useful features, as are the lamps which focus light on the front of the switchboard and the converter [3].

4. The TSLs on the SB-3614 are easier to see than the "cat eye" TSLs on other switchboards [1].

5. Useful controls on the front of the switchboard include the dimmer dial, the tone volume dial, and the lamp test switch which insures that all lights are operational [1].

6. The identification strips that go with the TSLs are large enough and easy to write on and erase [5].

7. The stand that sets the converter at an angle makes the front of the converter easier to see thus facilitating the task of the operator [4].

8. The headset is easily connected to the switchboard [4].

9. The handles on the ends of the switchboard are strong; it can be carried by one man or carried easily by two men [2]. If the switchboard

is upside down when lifted, however, the carriers' fingers can be pinched between the handle and the end of the switchboard [1].

Negative features:

1. Having the converter separate from the switchboard increases the number of items the operator must contend with. The operator receives information from two sources and he must manipulate controls at two different points [2].

2. When the switchboard is used in conjunction with the converter, the buttons associated with the TSLs and with some button controls on the switchboard are not needed [2]. If the converter were integrated into the switchboard, the buttons could be eliminated leaving only the TSLs to inform the operator which lines are in use [1].

3. The white lights in the TSLs and in the control buttons may affect operator's night vision. Colored lights might be substituted [2].

4. The bulbs in the TSLs and control buttons are very small and replacement is difficult, especially in poor light [1].

5. The stops, which are supposed to restrict rotary motion on the light brightness dial, are flimsy and became inoperative on one switchboard; however, this failure did not interfere with use of the dial [2].

6. There is some confusion between the "test tone" and the "tone send" button controls. Although they look similar, they involve different procedures. Also the "test tone" control involves one of two different proceudres depending on the configuration of equipment [1].

7. Four of the button controls on the converter have not been used with equipment as operated to date. If these four controls are not needed, they should be eliminated from the board [1].

8. Some controls on the switchboard are at one end of the front side; other controls are at the opposite end. It might be better if they were all at one end [2].

INSIDE FRONT OF SWITCHBOARD

Positive features:

1. The size, shape, position, and required movements of the toggle switches inside the front of the switchboard are satisfactory [6].

2. The diagram on the card retainer indicates the correct position for switches on the magneto terminal cards [5], but no diagram is provided for switches on the OTMF/dial cards [1].

3. Generally, there is no problem in determining which printed circuit cards go in which slots inside the switchboard [6]. The cards are keyed so they annot be inserted in the wrong slot. It is especially easy to see which cards go with which toggle switches [2]. All even channels go to the top and all odd channels go to the bottom and the numbers are marked on the card retainer; there is no difficulty, therefore, in knowing which end of the card goes up [1]. If one card is inserted upside down the retainers will not go in [1]. However, on the cards that go in slots without toggle switches, identification numbers would be useful to show the correct slot [1]. Another drawback is that the markings on the operational cards and the markings referred to in the technical manual do not correspond [1].

Negative features:

1. Before the front panel of the switchboard can be removed and access to the interior gained, 18 screws must be removed from the panel. The screws at the bottom of the panel are difficult to remove because they are directly below the bottom row of TSLs [3]. The time and effort required to remove or tighten down all 18 screws is annoying [5].

2. The front panel is hinged at the top to expose the interior of the switchboard. Because the panel swings up only 90^{o} and stays without assistance at only 80^{o} , it is difficult to work on the interior [6]. If the switchboard is sitting on a table, the operator must bend over or kneel, or tilt the switchboard back in order to see inside [3]. Then it is still difficult for him to see because the panel prevents most overhead light from reaching the interior [1]. When the panel is in the open position, a number of wires hang down from the panel in front of the upper part of the opening. When printed circuit cards are removed, they may snag one of these wires. This makes the operator's task more difficult, and wires may be pulled loose [3]. Having the front panel swing up, however, may be an advantage at times: it allows the operator to operate the switchboard when the front is open [1].

3. In order to remove printed circuit cards, the two card retainers must be removed first. Each retainer has eight screws which must be removed. No screwdriver is provided with the switchboards [3]. The screws in the top retainer are difficult to remove or insert because the front panel and wires from that panel partially mask the opening [2]. The time and effort required to remove the card retainers is annoying to operators [3]. When the card retainers are removed, the screws are easily lost because the device to secure them to the retainer is not very effective [?].

4. No card puller is provided with the switchboard, making it necessary to pull the printed circuit cards with one's fingers or with a pair of needlenose pliers [4]. Consequently, the fingers and/or the cards may be damaged.

5. The plastic keys inside the switchboard, which prevent the printed circuit cards from being incorrectly inserted, sometimes pull out with the card. Maintenance personnel are required to replace the keys [1].

BACK OF SWITCHBOARD AND CONVERTER

Positive features:

1. The power cable is easy to connect to the back of the switchboard [2]. Although there are three different power sockets on the switchboard, the cable cannot be plugged in the wrong one because each has a different pattern of notches that must fit with the cable in order for the connection to be completed [2]. The caps which protect the power input socket are easy to install and remove and are secured to the switchboard by a small but strong cable [1].

2. The converter cable is well marked to reduce the chance that it might be installed backwards [2].

3. All printed markings on the back of the switchboard and converter are readable and understandable [6].

4. The switches and dials on the back of the switchboard and converter all have adequate size and shape [6].

5. The wing nut for connecting the ground wire is adequate in size, shape, and location [4].

6. The terminal connectors on the back of the switchboard are arranged in a pattern which allows the operator to easily locate any pair of connectors he desires, even in the dark [6].

Negative features:

1. The wires in the power supply cable are not well marked to indicate how they should be connected to the plug [1].

2. The converter cable is difficult to install and remove from the switchboard [6]. The space between the socket for the cable and the power module is very small, and the socket is also very close to a screw that protrudes approximately 3/8 inch above the back panel of the switchboard. This makes it difficult to insert the cable plug in the socket and turn the locking ring to complete the connection [6]. One potential problem is that the pins in the pug are very slender and may become bent when the operator is attempting to make the difficult connection [3].

3. The holes in the terminal connectors are too small to readily accept multistrand WD-1 and WF-16 wire [6]. The wire tends to separate,

causing poor connections, and a strand could cross over and short the circuit [2]. The problem makes the multistrand wire difficult to connect in daylight and nearly impossible to connect in the dark [1]. In addition, the tension springs in the terminal connectors are relatively weak; this weakness allows wires to slip out of the connector unless the operator remembers to pull up on the connector to make it hold the wire more tightly [3].

OPERATING SWITCHBOARD

Positive features:

1. The SB-3614 can be set up more quickly than other comparable switchboards [1].

2. During operations to date, operators have experienced no undue fatigue when monitoring the switchboard [4]; however, it was operated in the automatic mode. It is relatively easy for an operator to learn to operate the switchboard [3]. Once the basic procedures are learned, the SB-3614 is easier, faster, and more fun to operate than a manual switchboard [2].

3. The "call waiting" alarm alerts the operator when he is needed, even if he is not closely monitoring the switchboard [2].

4. The headset is comfortable to wear [3].

5. The weight of the switchboard and converter is such (85 lbs) that the apparatus can be easily transported by vehicle. However, because of its bulk and weight, it would be difficult to backpack very far [2].

Negative features:

1. The power module generates a high-pitched noise which is annoying to those close to the switchboard [2]. To date, however, no occurrence of headache has been associated with the noise.

2. Some noise is experienced in the headset [1].

CONCLUSIONS

The findings indicate that although the SB-3614 automatic switchboard appears satisfactory in many respects, there are design features that need reconsideration. The interviews provided no data to indicate that there should be any major personnel or equipment quantity changes in TOE requirements as a result of introducing the SB-3614. There were, however, indications that operators of manual switchboards will require additional training to install, operate, and maintain the SB-3614 effectively.